Grade: 9/10 **Subject:** Electricity **Teacher:** Cornwall	**Date:** **Period(s) Req: 2**

Lesson Plan: Introduction to Magnetism and Its Connection to Electricity

Overall Curriculum Expectations

- **A1. describe the components and systems of buildings, the properties of various building materials, and the processes in which those materials are used;**
- **B1. design construction projects, individually or in small groups, applying a design process to plan and develop the projects and other problem-solving processes to address various related problems and challenges;**
- **C2. use fabrication and assembly techniques safely, accurately, and in the correct sequence;**

Specific Curriculum Expectations

- **A1.3** identify natural and manufactured building materials and products commonly used in the construction industry, and describe their specifications and characteristics;
- **B1.2** use appropriate problem-solving processes and techniques (see pp. 16–19) to address various specific problems or challenges that may arise in connection with a construction project.
- **C2.2** fabricate and/or assemble project components in a logical and efficient sequence

Learning Outcomes: *upon successful completion of this lesson, the student will be able to;*

- Define magnetism.
- Discuss the properties of permanent magnets.
- Demonstrate the operation of electromagnets.

Expectation: Students will participate in a guided discovery and lab-based learning experience. They will work in small groups to build and test electromagnets and explore how magnetic fields are used in construction technology and energy systems.

Materials & Resources:

- YouTube video 1,
- Timer, station signs, masking tape
- Computer, Projector, and screen
- Bar and horseshoe magnets
- Iron filings and paper sheets
- Copper wire, D-cell batteries, nails
- Pre-printed student fact sheet and worksheet
- Safety goggles

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Teacher Tasks	Timer
"Welcome back, today we will be discussing [lesson topic]. By the end of today's session, you will be able to define magnetism and describe its properties, fabricate a working electromagnet, and identify uses of magnets in tools and construction.	75 minutes total
Bell Work **Prompt:** "List one construction tool or system you think might use a magnet. Why might it use one?" *Take attendance while they work on this*.	5 min
Introduction and Hook **Play Video:** "Magnets in Real Life" – focusing on construction tools like magnetic levels, stud finders, and solenoid valves. **Ask:** "What do these tools have in common?" **Group Discussion:** Video Link:	5 min
Pre-video or Discussion Preparation **Ask:** "Have you ever seen a tool that holds something without nails or glue?" **Handout: Fact Sheet**	5 min
Video Viewing or Interactive Presentation Explain what your activity is, do your demo, bridge the gap to the student **Teacher demonstrates:** • Magnetic field visualized using iron filings. • Homemade electromagnet using wire-wrapped nail and D-cell battery. Video Link:	15 min
Activity or Discussion 1. **Iron filings over magnets –** map the field o Sketch and label observed fields and forces 2. **Build an electromagnet –** observe strength differences o **Students will follow the project guide sheet to build electromagnets from D-cell batteries, a paperclip switch and a coil wrapped around a nail.**	30 min
Consolidation and Reflection **Ask:** "How is this connected to net-zero design?" *Highlight the use of electromagnetic systems in renewable energy tech (e.g., wind turbines, solenoids in automation).* **Group Discussion:** *Revisit and restate the learning.*	10 min
Exit Ticket **Prompt:** "Describe how magnetism is used in a tool or system and why it's more efficient than mechanical alternatives."	5 min

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Key Terminology 1. Magnetism 2. Electromagnetism 3. Solenoid 4. Magnetic Field 5. Induction 6. Polarity 7. Circuit	

Assessment:

- **Diagnostic:** Bell Work prompt will help assess prior knowledge and misconceptions.
- **Formative:** Observations at hands-on stations and responses during group discussion.
- **Summative:** Exit ticket and completed worksheet, evaluated against learning goals.

Comments

1. **Next Lesson:** Intro to Circuits (Ohm's Law)
2. **Prerequisite Knowledge:** None

Notes

This lesson is designed as an inquiry-based entry point into energy systems and electromagnetism for students with no prior exposure. Tools are selected from real-world construction environments.

Learner Profile	Support Strategy
Visual Learners	Field maps, iron filing demos, video
Kinesthetic / Hands-On Learners	Hands-on station work
Auditory Learners	Discussion and teacher-led explanations
Reading/Writing Learners	Guided worksheet, glossary
Literacy Support	
ELL	Pairing, bilingual glossary (if available), gestures
Advanced Learners	Challenge to model polarity changes
Struggling Learners	Scaffold vocabulary, assign visual observation tasks

Sentence Starters:

"I think this tool uses magnetism because..."
"I was surprised when the magnet..."
"Electricity and magnetism are connected because..."

Rubric (Growing Success)

Criteria	Level 1 (Limited)	Level 2 (Some)	Level 3 (Considerable)	Level 4 (High Degree)
Understanding of Concepts	Demonstrates limited understanding of magnetism and its link to electricity	Demonstrates some understanding of basic magnetic concepts	Demonstrates clear understanding of magnetic and electrical relationships	Demonstrates deep understanding with clear connections to real-world construction systems
Application of Skills	Requires frequent support to complete electromagnet tasks safely	Completes task with some accuracy and supervision	Accurately builds and tests electromagnet with safe handling	Independently builds, tests, and explains functionality with efficiency and safety
Communication of Ideas	Communicates ideas with limited clarity or accuracy	Communicates basic understanding using some subject vocabulary	Communicates ideas clearly using appropriate terminology (e.g., field, polarity)	Effectively explains concepts using precise vocabulary, diagrams, and examples
Collaboration and Participation	Participates with prompting; minimal collaboration	Participates inconsistently; some collaboration	Participates actively and respectfully in group tasks	Engages others, leads or models effective teamwork, and supports peers
Reflection and Self-Assessment	Provides minimal insight in worksheet and exit ticket	Reflects on learning with basic ideas and connections	Reflects meaningfully and connects learning to construction or energy systems	Demonstrates critical reflection and makes personal or industry-based extensions

Making an Electromagnetic Crane

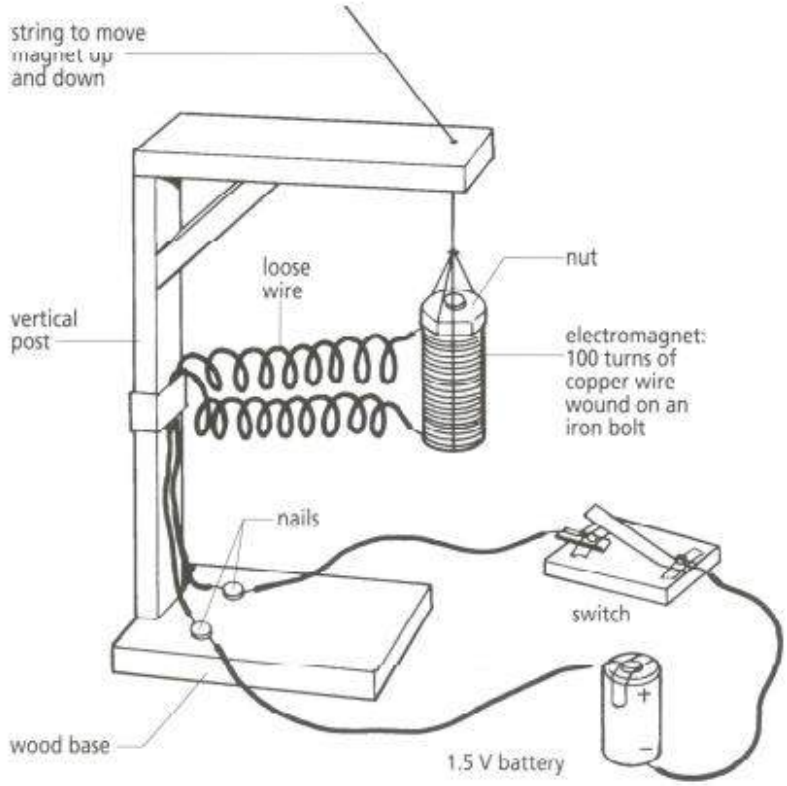
In the manufacturing and construction industries, electromagnets are used to pick up heavy pieces of metal.

Materials List

1.5V Battery/D-Cell Battery
Iron bolt, about 5cm/2in long
30 gauge insulated copper wire
1 meter of string
2 nails, 2.5cm/1in long
Wood base, 2cm x 20cm x 12cm pine
Vertical post, 2cm x 2cm x 25cm pine
Horizontal arm, 2cm x 2cm x 15cm pine
Diagonal support, 2cm x 2cm x 5cm pine@45°
Switch Base, 2.5cm x 5cm x 5 cm pine
2 thin metal strips
Carpenters glue
Finishing Nails
Tape

Fabrication

1. To make the electromagnet, wrap the bolt with about 100 turns of the copper wire. Leave enough wire at the beginning and the end to extend to the nail connectors. Cut two shorter pieces of wire to connect the nails to the switch and the battery.
2. To make the structure, drill a hole wide enough to thread the string through about 2 cm from one end of the horizontal post.
3. Assemble the vertical, horizontal, and diagonal members using glue and finishing nails. Attach the horizontal post to the base with glue and finishing nails.
4. Hammer the 2.5 cm nails into the base about 1 cm in from each side (see the diagram). Do not hammer them in all the way, so you can connect the wires to them. The insulation will have to be removed from the ends of the wire at all connections for the circuit to work.
5. Suspend the electromagnet with string from the horizontal post.



6. Make the switch by nailing 2 metal strips to the base as shown in the diagram. Bend the longer strip up; in this position, the circuit will be broken. Connect the wires to the switch with tape as shown.
7. Use tape to connect the wires to the 1.5 V battery. When the circuit is closed, the electromagnet will be charged and should pick up metals that contain iron.
8. Experiment with lifting different metals with the electromagnet.

Introduction to Magnetism Fact Sheet

What is Magnetism? Magnetism is a physical phenomenon caused by the motion of electric charges. It results in attractive and repulsive forces between objects. When many atoms in a material have their electrons spinning in the same direction, their magnetic fields combine to form a magnetic domain.

Key Concepts

1. **Magnetic Fields**
    - Invisible lines of force that surround a magnet.
    - Travel from the North Pole to the South Pole.
    - Strongest at the poles of the magnet.
    - Field lines never cross.
2. **Magnetic Poles**
    - Every magnet has two poles: North and South.
    - Like poles repel; opposite poles attract.
    - Poles cannot be isolated (you can't have just a North or South pole alone).
3. **Magnetic Domains**
    - Groups of atoms with aligned magnetic fields.
    - In magnetized materials, domains point in the same direction.
    - In unmagnetized materials, domains are randomly oriented.
4. **Magnetic vs. Non-Magnetic Materials**
    - Magnetic: Iron, Nickel, Cobalt, some Steel.
    - Non-Magnetic: Aluminum, Copper, Plastic, Wood.
5. **Electromagnetism**
    - Electricity can produce magnetism: wrapping wire around an iron core and running current creates an electromagnet.
    - The strength increases with more coils or higher current.
6. **Magnetism in Technology**
    - Found in motors, speakers, relays, transformers, and magnetic locks.
    - Used in recycling centers to separate ferrous metals.
    - Critical in electric motor control and generators.

Real-World Connections

- Electric Motors: Convert electrical energy into motion using magnetic fields.
- Relays: Use electromagnets to open/close circuits.
- Magnetic Levitation: Used in MagLev trains to eliminate friction.

Quick Definitions

- **Magnet:** An object that produces a magnetic field.
- **Ferromagnetic:** Materials strongly attracted to magnets.
- **Electromagnet:** Temporary magnet powered by electricity.
- **Polarity:** Directional property of magnets.
- **Domain:** Aligned region of magnetic atoms.
- **Flux:** Magnetic lines of force.
- **Lodestones:** Natural magnets.
- **Permanent Magnet**: Magnets that do not require an external force to maintain their magnetic properties.

Intro to Magnetism Worksheet

Name: _____ Course: _____ Date: _____

Bell Work

Question: Write down everything you already know (or think you know) about magnets. Don't worry if you're not sure.

Identify the Magnetic Materials

Instructions: Circle the materials that are magnetic:

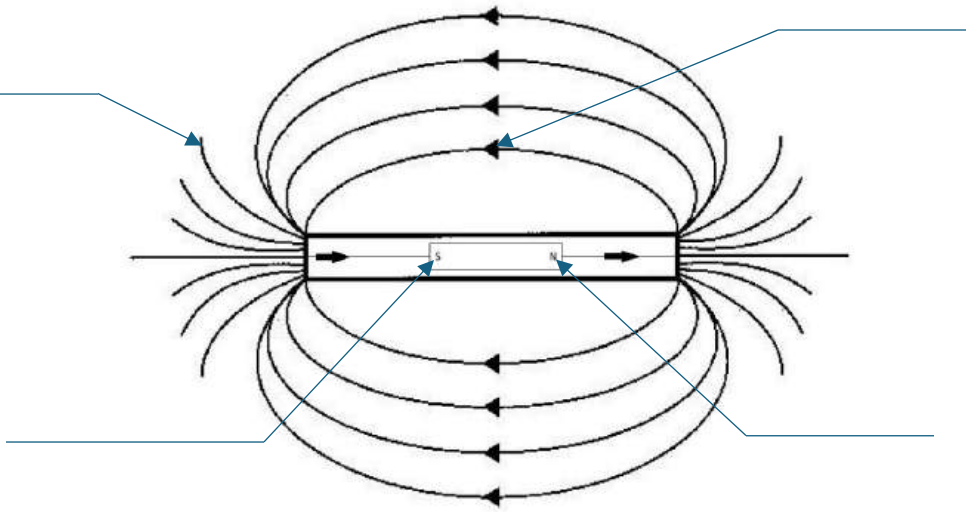
- Wood
- Iron
- Nickel
- Plastic
- Cobalt
- Copper
- Aluminum
- Steel

Label the Diagram

Instructions: Use the word bank to label the magnetic field diagram of a bar magnet.

Word Bank:

- A. North Pole
- B. South Pole
- C. Magnetic Field Lines
- D. Direction of Force



Vocabulary Match

Instructions: Match the term to its definition.

A. Ferromagnetic
B. Domain
C. Electromagnet
D. Polarity
E. Magnetic Field

1. ____ The area around a magnet where magnetic forces act.
2. ____ Materials like iron or cobalt that respond to magnets.
3. ____ Temporary magnet created by electricity.
4. ____ Region in a material where atoms align.
5. ____ Directional property (north/south) of a magnet.

Application Questions: Why is magnetism important in electric motors? How do magnetic fields help convert electricity into motion?

Reflection

Prompt: What part of today's lesson helped you understand magnets better? What's one question you still have?

Exit Ticket

Question: What's the difference between a permanent magnet and an electromagnet?